NEW TRENDS IN NUCLEAR DATA RESEARCH FOR MEDICAL APPLICATIONS

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Radioactivity has the unique character of being useful in medicine both for diagnosis and therapy. Whereas in diagnosis suitable γ-ray or positron emitters are needed for application in Single Photon Emission Tomography (SPECT) or Positron Emission Tomography (PET), for therapy, especially internal radiotherapy, soft but highly ionising radiation emitting radionuclides are required. Therapy is also performed with hadrons. This review describes briefly some recent developments and new directions in nuclear data research related to both diagnosis and therapy.

The production and decay data of all the commonly used SPECT and PET radionuclides are generally well known, and are also well documented. A new trend involves the use of longer-lived positron emitters, with one or the other of the following objectives:
(a)to study slow biological processes
(b)to quantify a new SPECT agent via analogue approach
(c)to optimise dosimetric calculations with regard to therapy planning
The development of a new positron emitter demands considerable work on charged particle induced nuclear reactions to be able to choose an appropriate production route. Some recent studies related to the development of the positron emitters ^{124}I ($T_{1/2}$ = 4.2 d), ^{94m}Tc ($T_{1/2}$ = 52 min) and ^{86}Y ($T_{1/2}$ = 14.7 h) will be described as typical examples. The formation of isomeric states constitutes a new challenge, not encountered in the production of commonly used PET radionuclides. Appreciable effort is also involved in determining the exact decay data of the new positron emitter, particularly the positron branching ratio, the average positron energy and the γ-rays associated with the decay, especially when quantitative PET-imaging is the aim. For production of most of the longer-lived positron emitters a 40 MeV cyclotron may be adequate. However, in some cases data in the intermediate energy range up to 100 MeV are needed. In a few rare instances, for example search for positron emitters in the region of rare earths, even exotic heavy-ion and spallation reactions are being considered.

As far as hadron therapy is concerned, atomic and molecular data are of primary concern. The nuclear data generally pertain to scattering and neutron and charged particle emission processes. For energies up to 200 MeV those data are generally well-documented; they can also be calculated rather well. In contrast, there has been some lack in the availability of activation data in proton therapy. A recent study on the formation of short-lived positron emitters in the tissue under proton therapy conditions will be described.

The therapeutic radionuclides are generally produced in a nuclear reactor and the data are known well, though not properly evaluated and organised. Enhanced efforts have been devoted in recent years to development of radionuclides for internal radiotherapy, generally low-energy β^- emitters or Auger electron emitters. Nuclear reaction cross section measurements for the formation of those radionuclides, especially via charged particle induced reactions, are rather challenging. Here interdisciplinary techniques of sample preparation and radioactivity measurement (x-ray spectrometry, liquid scintillation counting etc.) are needed. The very promising therapeutic radionuclide ^{225}Ac is obtained by processing of burnt up fuel. An alternative route involves handling of a radioactive target. The produc-

tion of some conventional therapeutic radionuclides using a fast neutron spectral source has also been considered: A brief review of all those developments will be given.

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